

# of the Angola-Benguela Front during winter 1999

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There is growing recognition that frontal systems are regions of high productivity and influence the distribution of biota across most of the trophic spectrum.<sup>1,2</sup> The Angola-Benguela Front (ABF) is a comparatively little studied frontal system at about 14–17°S off southern Angola. This is a seasonally highly variable hydrographic feature separating the Angola and Benguela currents. These current systems are characterized by different physical, chemical and biological properties (see various contributions elsewhere in this issue). Information on how physical and

biological processes in the region of the ABF interact and influence biological production and the spatial distribution of biota is scarce. Little is known, for instance, about the spatial variability and taxonomic composition of zooplankton in this frontal boundary region.

As part of the 1999 BENEFIT Shipboard Research Training Programme in the SADC Region,<sup>3</sup> zooplankton samples were collected from the Namibian RV *Welwitchia* using a 200- $\mu$ m meshed Bongo-net system, towed obliquely in the upper 200 m between Walvis Bay (23°S) and Luanda (9°S) during 24 July–1 August 1999 (see Fig. 5 in ref. 3). The samples were analysed during a BENEFIT Zooplankton Identification Training Workshop<sup>†</sup> and revealed distinct longshore and cross-shelf patterns in numerical abundance, distribution and taxonomic composition of zooplankton. These patterns were associated with different water masses, identified from sea-surface temperature (SST) data,

Stations within the ABF region (SSI: 18–21°C) were characterized by elevated abundances of total zooplankton (Fig. 1a), on average  $93.0 \pm 17.3 \times 10^3$  ind. m<sup>-2</sup> (mean  $\pm$  1 s.e.), compared to the warm Angola Current waters (22–24°C) to the north with  $33.9 \pm 8.7 \times 10^3$  ind. m<sup>-2</sup> and the cool Benguela Current waters (14–17°C) to the south with  $28.8 \pm 6.7 \times 10^3$  ind. m<sup>-2</sup>.

Throughout the survey area, calanoid copepods were the most abundant, comprising roughly between 50 and 60% of the total zooplankton (Fig. 1b). Cyclopoid copepods were relatively more abundant in the Angola Current region (14%) than elsewhere (5–6%). Gelatinous zooplankters were more abundant in the Benguela Current region off Namibia (19%) than in the Angola Current region (5%), and represented only 2% of the total zooplankton within the ABF. Euphausiids made up 26% of the zooplankton in the latter region, while only 14% to the north of it and 12% to the south. Chaetognaths were fairly uncommon, making up merely 3–8% of total zooplankton abundance. Other taxa, which included cladocerans, polychaetes and some other, less common groups represented between 5 and 11% of the total abundance in the respective regions.

A 90-n mi transect along the 20°S

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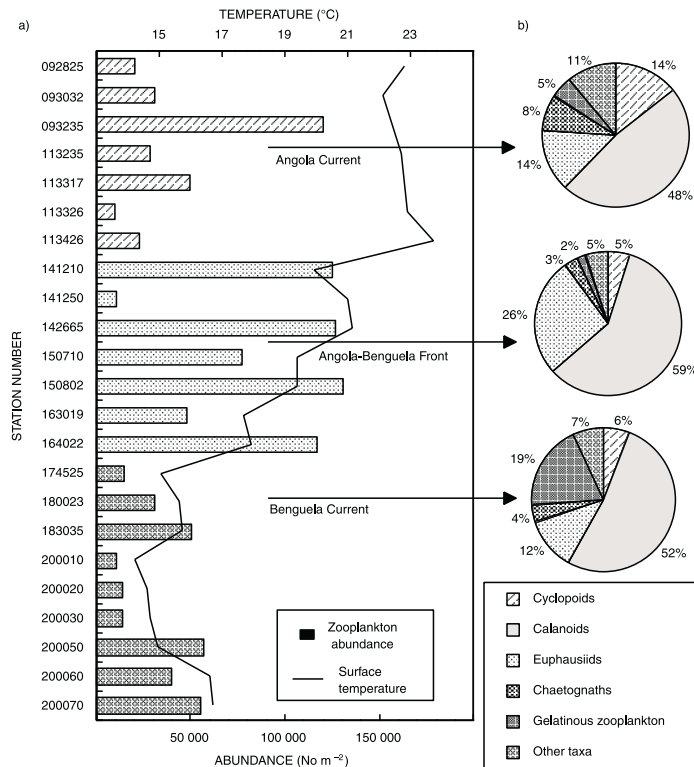
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**Fig. 1. a,** Longshore distribution and depth-integrated total abundance ( $\text{No. m}^{-2}$ ) of zooplankton in the upper 200 m in the region of the northern Benguela and Angola-Benguela Front, with sea-surface temperature superimposed showing three distinct water masses. The first four digits of the station numbers refer to latitudinal station position (XX°YY'S), the last two indicate distance offshore in nautical miles; **b,** mean taxonomic composition (%) of zooplankton in the samples pooled for each of the three water masses.

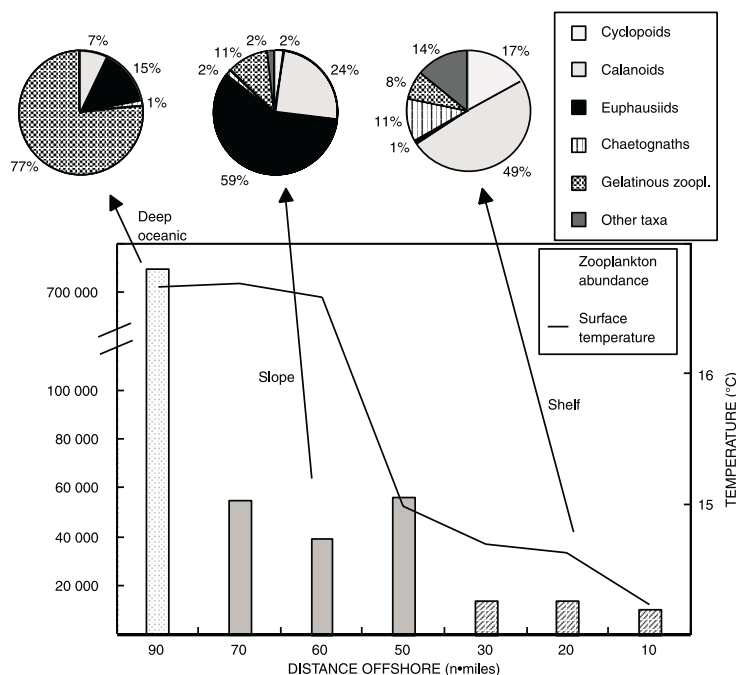
latitude off northern Namibia provided an opportunity to investigate cross-shelf distribution patterns of zooplankton (Fig. 2). There was a marked in-shore–offshore trend in total zooplankton abundance, with lowest numbers associated with the cooler ( $<15^{\circ}\text{C}$ ) shelf waters,

on average  $12.7 \pm 2.2 \times 10^3 \text{ ind. m}^{-2}$ , increasing to  $49.0 \pm 4.9 \times 10^3 \text{ ind. m}^{-2}$  in warmer ( $15\text{--}17^{\circ}\text{C}$ ) water over the slope, and reaching a distinct peak of  $747.1 \times 10^3 \text{ ind. m}^{-2}$  in deep oceanic water at the outermost station. Of the crustacean fraction, copepods dominated the shelf commu-

nity (66%), whereas euphausiids were the most abundant in the slope region (59%). By contrast, gelatinous zooplankters were most prominent at the outermost station (77%), where salps accounted for the highest zooplankton density observed during the cruise. Although much less abundant than the aforementioned groups, chaetognaths (11%) and 'other taxa' (14%) were comparatively far more important on the shelf than further offshore ( $<2\%$ ), a trend similar to that observed for the copepods.

This study, although based on sample analyses at a coarse taxonomic resolution, illustrates the distinct association of zooplankton communities with the hydrography of the Angola and Benguela current systems. In addition to cross-shelf variability, there were marked changes in zooplankton species composition and abundance across the ABF. The importance of the ABF frontal boundary in supporting increased zooplankton levels is highlighted, with especially crustaceans being able to maintain high population densities, likely by combining behavioural traits with specific features of the circulation system. It is suggested that the ABF is a site of either physical accumulation or convergence of planktonic organisms, or enhanced productivity, or both. A more rigorous assessment of spatial gradients in the abundance of zooplankton at both the species and developmental stage levels may provide more clarity on these hypotheses.

\*Sponsored by the BENEFIT Programme, the workshop was convened by Hans M. Verheye of Marine and Coastal Management Coordination (M&CMC) in Cape Town, South Africa and held at the National Marine Information and Research Centre (NatMIRC) in Swakopmund, Namibia, during 18–25 September 1999. It was a continuation of the training activities conducted during the BENEFIT cruises. Bringing together marine scientists and oceanographic technicians from Angola, Namibia and South Africa, the workshop aimed at contributing further to capacity building in marine science, particularly zooplankton research, in the Benguela Current region. We wish to thank BENEFIT, M&CMC and NatMIRC for financial and logistical support, as well as the Master and crew of the RV *Welwitschia* for their assistance at sea.



**Fig. 2. Bottom,** cross-shelf distribution and depth-integrated total abundance ( $\text{No. m}^{-2}$ ) of zooplankton in the upper 200 m along a transect at  $20^{\circ}\text{S}$  off Namibia, with sea-surface temperature superimposed; **Top,** mean taxonomic composition (%) of zooplankton in samples pooled for shelf, slope and deep oceanic stations.

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